

# PATENT SPECIFICATION

(11)

1 559 068

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- (21) Application No. 6303/78 (22) Filed 17 Feb. 1978  
 (31) Convention Application No. 67 365 (32) Filed 18 Feb. 1977 in  
 (33) Italy (IT)  
 (44) Complete Specification published 16 Jan. 1980  
 (51) INT. CL.<sup>3</sup> B23K 11/10  
 (52) Index at acceptance  
 B3R 10 2G 60



## (54) RESISTANCE WELDING MACHINE

(71) We, ELFIN S.P.A., an Italian joint stock company, of Via Piemonte 9, Borgaro Torinese, Turin, Italy, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to resistance welding machines.

It is already known, in welding plant for mass production, to control welding pincers, supported by a balanced support, by means of a robot manipulator operating according to a program to effect simple welding operations.

In such plant the welding pincers are connected by means of a flexible cable to a transformer located at a level higher than that of the pincers and slidable in one or

a transformer for supplying electrical energy to said pincers, and flexible cables and tubes supplying a welding current, coolant liquid, and driving fluid to said pincers, and further including pincer support means displaceable along its axis relative to the said support in a horizontal direction and rotatable in said support about a horizontal axis parallel to the axis of displacement, the transformer and the flexible cables and tubes being mounted for rotation together with the welding pincers about the said horizontal axis and the transformer having a body and a secondary winding which is mounted slidably in said transformer body and is fixed to the displaceable pincer support means, and movement control means for controlling, according to a predetermined programme, the joint axial displacement of the pincer support means

## ERRATA

### SPECIFICATION NO 1559068

Page 2, line 30, *for counterweights read* counterweights

Page 3, line 61, *for secondly read* secondary

THE PATENT OFFICE  
 26 February 1980

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to subject the cable and the flexible tubes to tension, which may give rise to inaccuracy in the displacements of the manipulator.

The present invention, with a view to avoiding the abovementioned disadvantages, provides a resistance welding machine comprising welding pincers carried by a horizontally and vertically movable support,

Figure 3 is a partial side elevational view of the machine in greater detail, on an enlarged scale;

Figure 4 is an end view of the machine, 85 partially sectioned on the line IV-IV of Figure 3;

Figure 5 is a sectional view on line V-V of Figure 4;

Figure 6 is a sectional view on line VI-VI 90

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 10 welding machines.

It is already known, in welding plant for mass production, to control welding pincers, supported by a balanced support, by means  
 15 of a robot manipulator operating according to a program to effect simple welding operations.

In such plant the welding pincers are connected by means of a flexible cable to a transformer located at a level higher than  
 20 that of the pincers and slidable in one or more directions; to the pincers there are connected flexible tubes for feeding cooling water and a driving fluid which powers a  
 25 pneumatic or hydraulic actuator which controls the opening and closing of the arms of the pincers.

The aforesaid cables and flexible tubes are liable to become kinked during the angular displacement of the pincers, limiting the angular excursion of the pincers and  
 30 therefore the performance of the machine.

Futhermore, when the manipulator has to make a substantial displacement, the transformer also has to be displaced, and it is  
 35 necessary to overcome the significant inertia of such components of the plant and to subject the cable and the flexible tubes to tension, which may give rise to inaccuracy in the displacements of the  
 40 manipulator.

The present invention, with a view to avoiding the abovementioned disadvantages, provides a resistance welding machine comprising welding pincers carried by a  
 45 horizontally and vertically movable support,

a transformer for supplying electrical energy to said pincers, and flexible cables and tubes supplying a welding current, coolant liquid, and driving fluid to said  
 50 pincers, and further including pincer support means displaceable along its axis relative to the said support in a horizontal direction and rotatable in said support about a horizontal axis parallel to the axis of displacement,  
 55 the transformer and the flexible cables and tubes being mounted for rotation together with the welding pincers about the said horizontal axis and the transformer having a body and a secondary winding  
 60 which is mounted slidably in said transformer body and is fixed to the displaceable pincer support means, and movement control means for controlling, according to a predetermined programme, the joint axial  
 65 displacement of the pincer support means and the transformer secondary winding, the joint rotation of the pincers and the transformer, working movements of the pincers, and displacements of the support along a  
 70 vertical axis and along a horizontal axis perpendicular to the axis of displacement of the pincer support means.

The invention will now be described with reference to the appended drawings, provided by way of non-limiting example,  
 75 in which:

Figure 1 is a schematic elevational view of a welding machine according to the invention;

Figure 2 is a plan view of the machine  
 80 shown in Figure 1;

Figure 3 is a partial side elevational view of the machine in greater detail, on an enlarged scale;

Figure 4 is an end view of the machine,  
 85 partially sectioned on the line IV-IV of Figure 3;

Figure 5 is a sectional view on line V-V of Figure 4;

Figure 6 is a sectional view on line VI-VI  
 90

of Figure 3;

Figure 7 is a perspective view of the assembly comprising the transformer and the pincers, and

5 Figure 8 is a partial perspective view of the transformer of the said assembly, on an enlarged scale.

In the drawings, reference numeral 1 indicates a flat bed 1 provided with horizontal guideways 1a upon which a carriage 2 is mounted for movement along a horizontal axis x-x, through interposed rolling bearings. The carriage 2 comprises a base 3, two upstanding pillars 3a and an upper cross-piece 3b. The displacement of the carriage 2 is controlled by an electric motor 4 through a chain 5.

A slide 6 is mounted for vertical sliding movement in the carriage 2. The displacement of the slide 6 is controlled by two chains 7, each of which is connected at its ends to appendages 8 of the slide 6 and which pass around sprocket wheels 9, 10. The weight of the slide 6 is balanced by means of counterweights 7a interposed in the chains 7. One of the sprocket wheels 10, situated in the base 3, is driven by an electric motor 11.

According to a variant of the illustrated embodiment the counterweights 7a may be replaced by pneumatic cylinders.

A cable drum 12 is mounted in the slide 6 for rotation about a horizontal axis. The ends 12a of the drum 12 are supported, through interposed bearings, on the internal surfaces of corresponding enlarged parts of the slide 6 as illustrated in Figure 5. The horizontal longitudinal axis of the drum, indicated by y-y, is perpendicular to the horizontal axis x-x along which the carriage 2 slides. The drum 12 has, between its ends 12a, a cylindrical skirt 12b provided with a toothed crown 13 which meshes with a toothed pinion 14 driven by an electric motor 14a which is mounted on the slide 6 (Figure 4).

In the drum 12 there is fixed coaxially a transformer 15 the external surface of which is engaged in a corresponding seating in the end 12a of the drum 12.

The transformer 15 comprises, as illustrated in particular in Figure 8, a primary winding 15a and a secondary winding 15b. The secondary winding 15b comprises a coil of copper tube of elliptical section mounted for sliding movement longitudinally relative to the primary winding within laminated iron sleeves 15c which extend between two end yokes 15d and which with the yokes 15d complete a magnetic circuit.

The ends 12a of the drum 12 are provided with ball bearing bushes 19 (Figure 6) in which two cylindrical tubular rods 17, 17b are supported for axial sliding

ends by two transverse members 18a, 18b so as to form a frame indicated by 16.

The secondary 15b of the transformer 15 is connected to the rod 17a by means of two axially spaced apart arms 20 which secure the secondary 15b rigidly to the frame 16, to follow the rotational and translational movement of the latter.

The frame 16 is displaceable axially by means of an electric motor 21 provided, like the other electric motors of the machine, with speed reduction gearing. The motor 21 is supported from the frame 16 through a support arm 30. The motor 21 effects rotation of a screw-threaded shaft 31 which is in threaded engagement with a nut 32 fixed to the drum 12. At its end opposite the support arm 30 the shaft 31 is supported in a bearing 38 carried by a support arm 39 fixed to the rod 17b. Rotation of the motor 21 in either direction causes a corresponding axial displacement of the frame 16 in either direction relative to the drum 12 and therefore relative to the slide 6.

Welding pincers 22 are pivotally mounted on the transverse member 18a for angular movement upon a transverse shaft 23. The welding pincers 22 comprise two pincer arms pivotable relative to each other about a pivot pin 22a parallel to and spaced from the axis of the transverse shaft 23.

Angular displacement of the pincers 22 about the axis of the shaft 23 is controlled by an electric motor 34 supported by the transverse member 18b of the frame 16. The motor drives a shaft 35 which is rotatably mounted within and extends coaxially through the tubular rod 17a, the shaft 35 driving the transverse shaft 23 through meshing bevel gears 36, 37.

Two short lengths of flexible cable 25a, 25b connect the secondary 15b of the transformer 15 to the two respective arms of the welding pincers 22 and supply to the latter, in the known way, both electrical power and cooling water.

The ends 12a, 12b of the drum 12 are provided with aligned holes 26 for the through passage of pipes 26a through which a driving fluid is supplied to an actuator 22b, for example a pneumatic actuator, which controls the opening and closing movements of the arms of the pincers about the pivot pin 22a.

From the preceding description it will be clear that the welding pincers 22 have five degrees of freedom:

1) translation along the horizontal axis x-x of sliding movement of the carriage 2;

2) translation along the vertical axis of sliding movement of the slide 6;

3) translation along the horizontal axis y-y of sliding movement of the frame 16.

4) rotation about the axis of the drum 12;

5) rotation about the axis of the transverse shaft 23 perpendicular to the axis of the said drum 12.

These degrees of freedom permit the utilization of the machine for effecting welding operations in many practical applications, rendering superfluous the greater number of degrees of freedom offered by expensive robot manipulators used for controlling separate welding machines.

The above-described movements of the welding pincers are controlled automatically according to a predetermined program by means of an electronic control unit 27 which may be arranged to control two or more welding machines of the type herein described.

#### 20 WHAT WE CLAIM IS:—

1. A resistance welding machine comprising welding pincers carried by a horizontally and vertically movable support, a transformer for supplying electrical energy to said pincers, and flexible cables and tubes supplying a welding current coolant liquid, and driving fluid to said pincers, and further including pincer support means displaceable along its axis relative to the said support in a horizontal direction and rotatable in said support about a horizontal axis parallel to the axis of displacement, the transformer and the flexible cables and tubes being mounted for rotation together with the welding pincers about the said horizontal axis and the transformer having a body and a secondary winding which is mounted slidably in said transformer body and is fixed to the displaceable pincer support means, and movement control means for controlling, according to a predetermined programme, the joint axial displacement of the pincer support means and the transformer secondary winding, the joint rotation of the pincers and the transformer, working movements of the pincers, and displacements of the support along a vertical axis and along a horizontal axis perpendicular to the axis of displacement of the pincer support means.

2. A machine as claimed in Claim 1, including a carriage movable on a bed along a first horizontal axis, the support comprising a slide displaceable vertically on said carriage, and a drum mounted in said slide for rotation about a second horizontal axis, perpendicular to the first horizontal axis, and wherein the displaceable support means carrying the pincers and the

transformer secondly winding are mounted for axial sliding movement in said drum, and the pincers are pivotally mounted on said support means about an axis perpendicular to the axis of rotation of the drum, the transformer, the electrical cables connecting the transformer to the pincers and the flexible tubes connected to the pincers being supported so as to participate in the rotation of the drum with respect to said support slide.

3. A machine as claimed in Claim 2, in which the transformer is fixed to the inside of the drum.

4. A machine as claimed in Claim 2 or Claim 3, including fluid pressure actuator means for controlling opening and closing movements of the welding pincers, and conduits extending through axial apertures in said drum for supplying working fluid to said actuator means.

5. A machine as claimed in Claim 2, Claim 3 or Claim 4, in which the displaceable pincer support means is constituted by a frame comprising two cylindrical longitudinal members mounted for axial displacement in said drum and two transverse members interconnecting adjacent ends of said longitudinal members, and including an electric motor connected to said frame for effecting controlled axial displacement of the latter.

6. A machine as claimed in Claim 5, in which the electric motor is carried by the slidable frame and including a screw-threaded shaft connected to said motor to be rotated thereby and a nut threaded upon said shaft and fixed to the drum said shaft being connected, in correspondence with one end, to one of the longitudinal members of the frame.

7. A machine as claimed in claim 6, including a horizontal shaft upon which the welding pincers are mounted and a further electric motor controlling rotation of said shaft.

8. A machine as claimed in Claim 7, including transmission means comprising a longitudinal shaft extending through one of said longitudinal frame members and bevel gearing drivingly connecting said further electric motor to said pincer support shaft.

9. A machine as claimed in any of Claims 2 to 8, in which the drum is provided with external gear teeth and including a toothed pinion meshing with said gear teeth and an electric motor driving said pinion.

10. A machine as claimed in any of claims 5 to 8, in which the drum has oppo-

site ends supported rotatably in the pincer support slide and a cylindrical skirt, said ends being provided with bushes for the sliding movement of the longitudinal frame 5 members which form part of the pincer support means and which are fixed to the secondary winding of the transformer.

11. A resistance welding machine substantially as herein described with reference

to and as shown in the accompanying drawings. 10

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FIG. 1

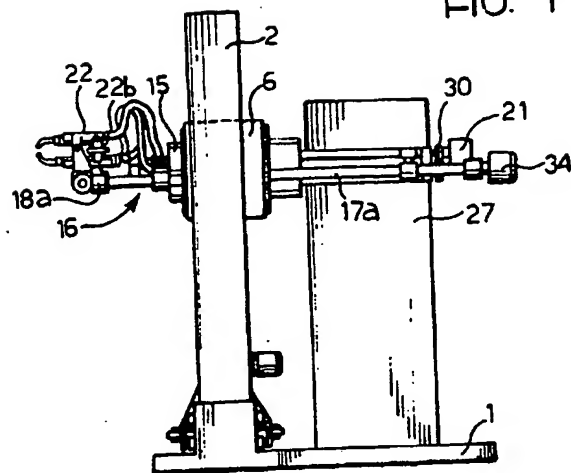
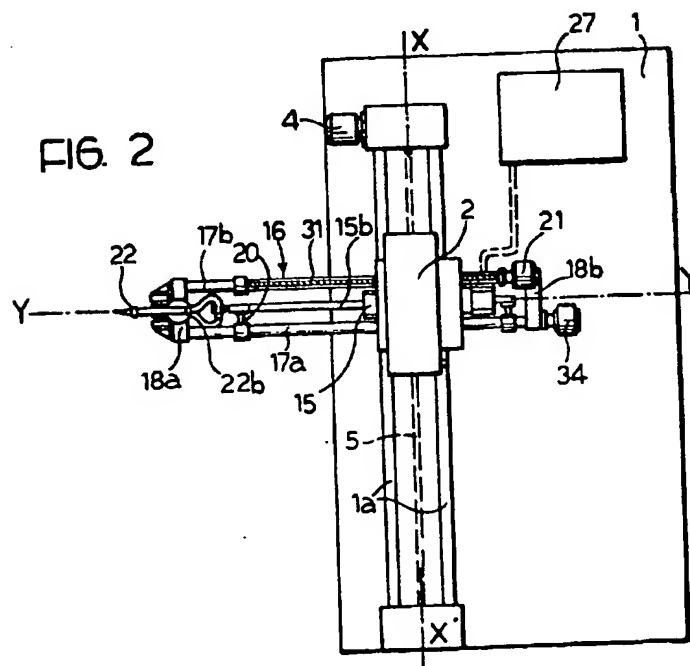
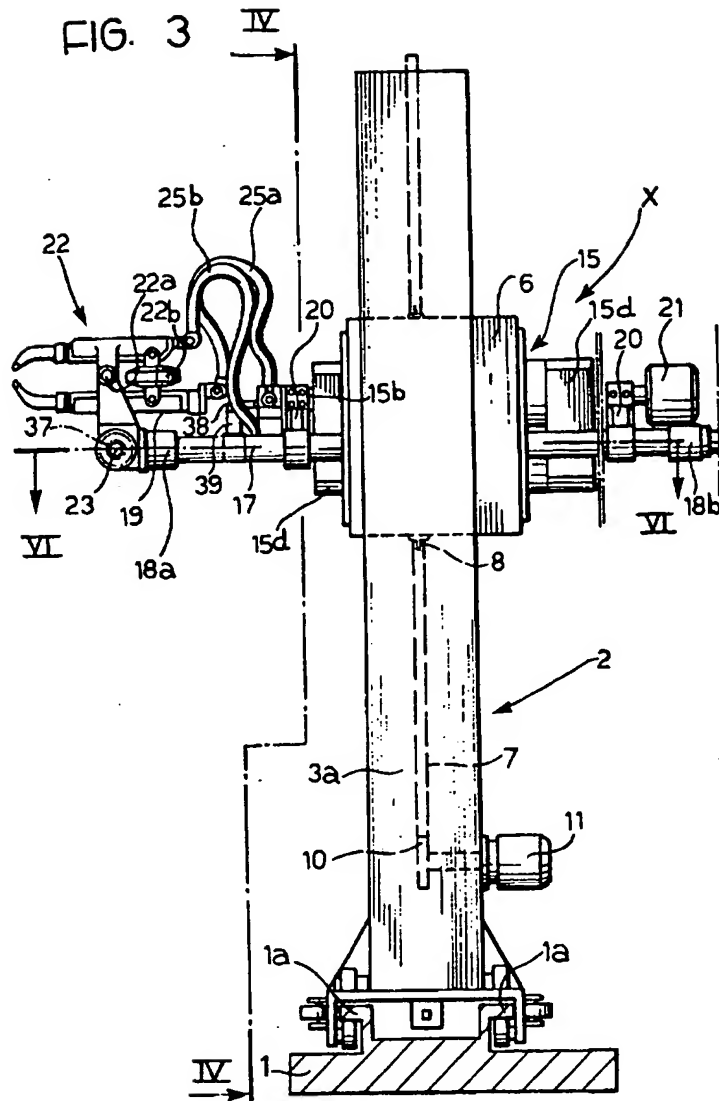


FIG. 2

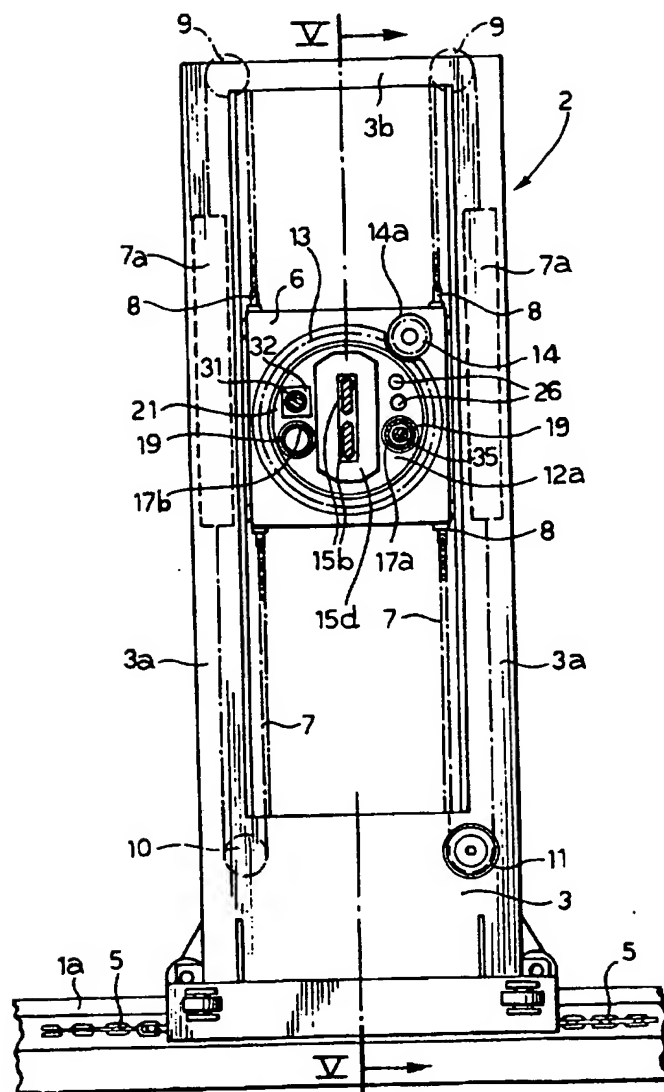




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**Sheet 3**

FIG. 4





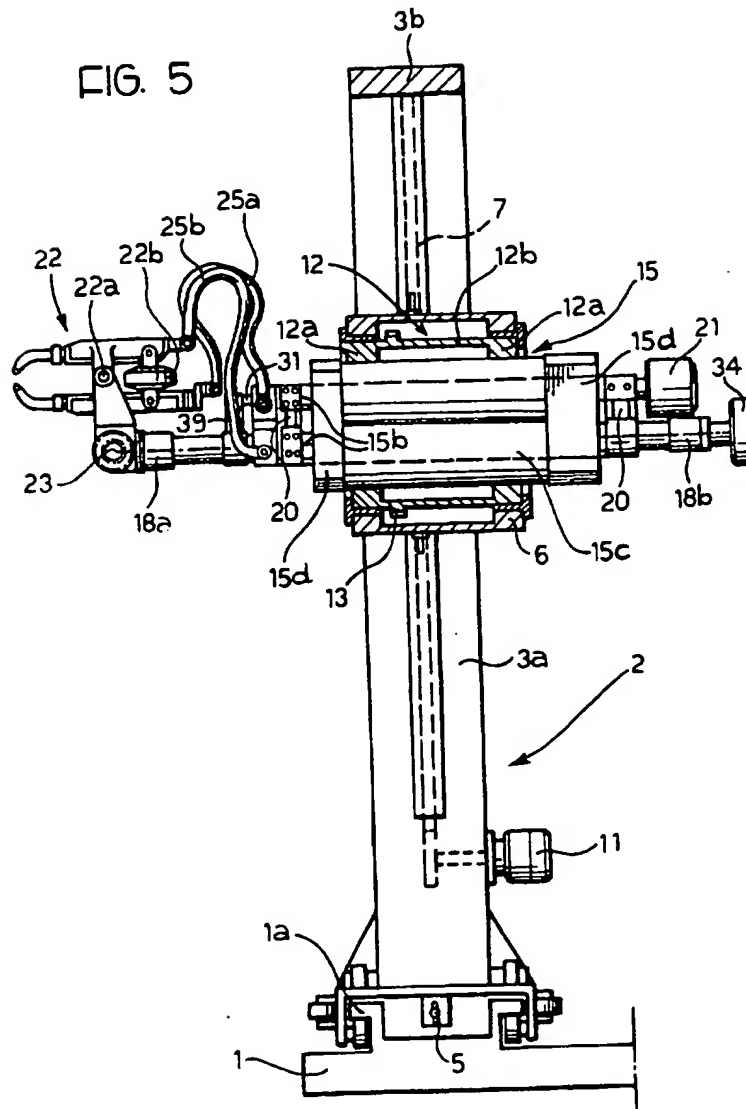
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6 SHEETS

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FIG. 5



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FIG. 6

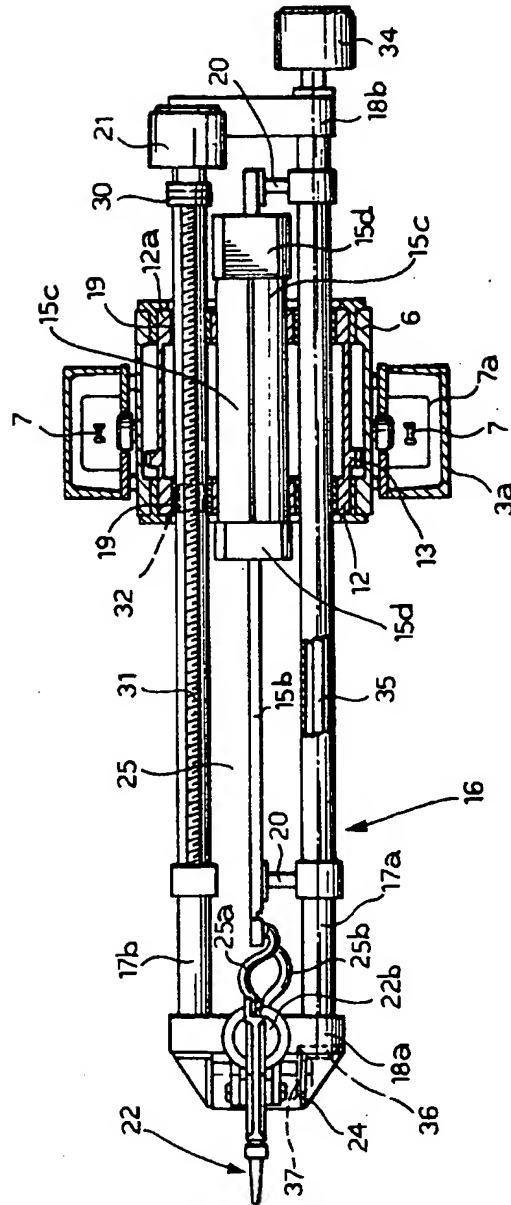


FIG. 7

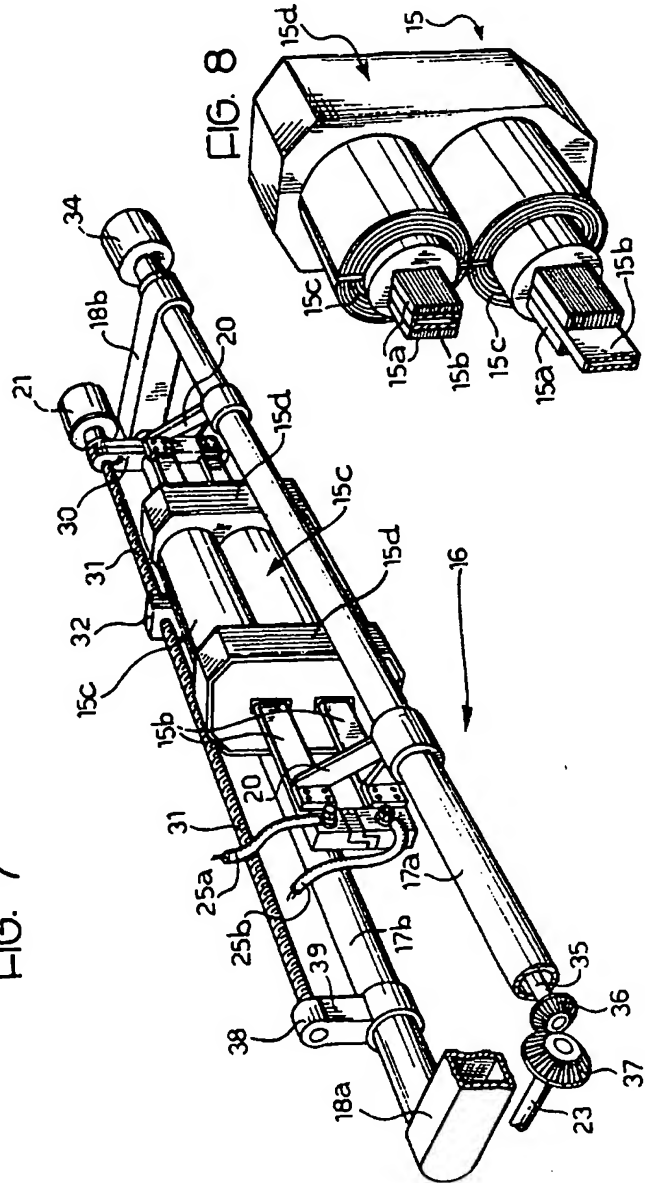
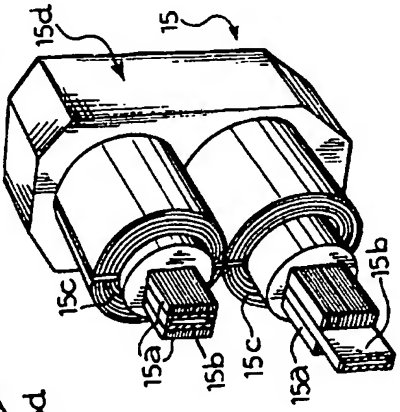


FIG. 8



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